REMARKS

Claim 1 was rejected for lack of particularly. Claims 1 and 6 were rejected as unpatentable over Smith in view of Marko. Claims 3 and 4 were rejected as unpatentable over Smith in view of Marko in further view of Carlson. Claim 5 was rejected as unpatentable over Smith in view of Marko in further view of Kim. Claim 7 was rejected as unpatentable over Smith in view of Marko in further view of Rattlingourd. Claim 8 was rejected as unpatentable over Smith in view of Marko in further view of Rattlingourd in further view of Kim in further view of Tucci. Applicant requests reconsideration.

It is not understood what is "page 3, paragraph [0023] lines 3-12. The specification was filed with page numbers and line numbers, and those should be used. The "adjusted timing signals" are incorrectly stated, and should be "adjusted timing pulses" (14). (See Figure 1 and claim 1) While the entire timing recovery loop is used to produce the adjusted timing pulses, the baseband signal 10 encodes the original bit timing. The specification teaches " The binary data and timing are encoded into the baseband signal waveform 10. The baseband waveform 10 is fed into a conventional data detector 11 and a pulse detector and comparator 12. The pulse detector and comparator 12 generates adjusted timing pulses 14 that can be used by the data detector 11 to sample the baseband waveform 10 to reconstruct the digital bit stream 15." It is the transition pulses detected from the baseband signal that give rise to the adjusted timing pulses. Hence, the specification teaches that the baseband signal includes the timing information

from which the adjusted timing pulses are generated. In Figure 1, there is a path extending from the baseband waveform 10 through the pulse detector and comparator 12 that generates the adjusted timing pulses 14. The specification and claims reflect this necessary path. Claim 1 is particular and accurate in this regard.

The timing pulse delay adjustor 16 does adjust the adjusted timing pulse delay routed from the adjuster 26 to the pulse and comparator detector 12. Claim 1 does not refer to a reference signal, as intended, nor is a reference signal found in Figure 1. Claim 1 vis-à-vis Figure 1 is accurate. Hence, the adjustor 26 adjusts the adjusted timing pulse delay, as claimed in claim 1, as described in the specification, and as shown in Figure 1. Claim 1 reads directly on Figure 1, without regard to an embedded reference clock signal in the pulse detector and comparator 12. However, Claim 1 was amended to more clearly recite that the timing pulse delay adjustor 26 adjusts the adjusted timing pulse delay.

Applicant extends appreciation for the thorough examination. The cited references describe improvements in early-and-late gate timing recovery. There are major differences between the early-and-late gate approach of the cited references and the claimed random walk filter. The early-and-late gate approach essentially detects the times of ascending crossing and descending crossing of a threshold level. This is well-known threshold detection. By noting the time differences between the estimated time at the center of the pulse and the early and late times of threshold crossing, the estimated time of pulse center is adjusted. The random walk filter,

on the other hand, counts the number of times over many data periods that the baseband waveform pulses that are obtained by differentiating the baseband waveform, lead or lag the corresponding delayed or adjusted reference timing pulses.

The random walk filter does not determine the amount of lead or lag for each pair of pulses that could be had by simple threshold detection, as in the cited references. The random walk filter sums, over many data periods, accumulative +1's, as a the total count for leads of any amount and -1's for lags of any amount, for indicating whether any adjustment to the reference timing pulse delay is needed, for improved synchronization with the baseband waveform. When the delayed reference timing pulses are synchronized with the baseband waveform, +1, -1 and 0 would be randomly distributed over the many data periods, with the total count resembling the Brownian motion, thus resulting in the name of random walk filter approach to timing recovery. This is the major difference between early-and-late gating and random walk filtering.

The random walk filter has a timing window that initially covers an entire data period, so that the random walk filter can always find the baseband waveform pulse corresponding to a particular adjusted reference timing pulse. The window can decrease to very small size as the baseband waveform is acquired and tracked. By contradistinction, the early-and-late gate window is centered at the pulse center and will always register each and every early and late crossings of the threshold. Depending on the

threshold level relative to the peak value, the window cannot be decreased below a specific size.

Thresholding has different meanings between the early and late gate and the random walk filter. The threshold for the early-and-late gate determines the time, relative to the pulse center, for the crossings. By contradistinction, the random walk filter uses two thresholds, the first threshold allows the count to be reset and the second threshold is set so that any count below that threshold would not result in any adjustment to the delay. This ensures that the random walk filter would not make adjustments based on noise. Thus, threshold for the early-and-late gate approach is an amplitude detection threshold while the two thresholds for the random walk filter approach are counting thresholds.

While the random walk filter may include conventional components as in the cited references, the random walk filter provides a fundamentally different approach to timing recovery. The random walk filter implements accumulative lead and lag counting over many data bits to achieve timing recovery, whereas the cited references use conventional localized threshold detection for timing about a pulse center. The cited references to not teach nor suggest accumulative lead and lag counting using random walk filtering over a large time period.

It is true that the reference timing pulses are locally generated. However, the adjusted timing pulses are corrected by the

random walk filter so that the adjusted timing pulses are synchronized with the baseband waveform for accurate bit detection.

The timing pulse delay adjuster (26) does not delay the adjusted timing pulses. It delays the reference timing pulses to produce the adjusted timing pulses to be synchronized with the baseband waveform.

Smith proposed a technique based on early-and-late gate phase comparator and reversible binary counter.

Marko also proposed an early-and-late gate technique using two digital phase lock loops with narrowband and wideband filters. These versions of the early-and-late gating are different to the random walk filter approach in several aspects.

Carlson also used the early-and-late gate technique by setting the early and late windows and detecting the timing data relative to the window centers. Again, while using some of the same components, this early-and-late gate approach is quite different than the random walk filter approach.

Kim used a training sequence with a predetermined pattern to synchronize incoming waveform with clock periods. Lead or lag information is then used for clock adjustment. This is a technique for acquisition before data waveform is received while the random walk filter approach performs timing recovery while processing data waveform.

Rattlingourd used an Oscillator to generate a signal at a fixed frequency (f), which is much larger than the data rate. Through a Variable Divider with value m (e.g., 200), a clock output signal is produced with rate f/m that is close to the data rate. A Phase Detector is then used to detect differences between the positive going and negative going edges of the data and the clocking edges of the clock signal. Its output drives an Up/Down Counter. A Window Counter also compares data edges with the clocking edges to assess the scope of the timing error. The outputs of the Up/Down Counter and Window Counter modify the value m of the Variable Divider. If there is no difference between data edges and clocking edges, the value m remains the same. When there is a difference, m would increase or decrease. Increasing m by unity essentially delays the arrival of the next clocking edge by one oscillator cycle, and the next clocking edge after that by 2 oscillator cycles, and so forth. Decreasing m has the opposite effect. The clock output signal rate is also affected by a change in the value m. The random walk filter approach, on the other hand, provides a time delay that shifts all the timing pulses. The delay is adjusted through by the output of the random walk filter. Thus, there are four differences between the approaches. Rattlingourd's technique adjusts the quantity f/m, which is the estimated data rate, while the random walk filter adjusts delay. Rattlingourd's oscillator generates a frequency much higher than the data rate, while random walk filter generates timing pulses at the data rate. Rattlingourd's approach requires that the timing comparison between data edges and clocking edges occurs at the clocking edges of the clock signal. The random walk filter allows the counting of a data transition pulse within a

large window, of the order of a data period, centered at the corresponding timing pulse. Rattlingourd's approach requires the adjustment of the parameter m to occur at the edges of the clock signal, while in random walk filter, the delay can be adjusted at any time. Rattingourd describes leads and lag with up and down counting and adjusts recovery timing by changing pulse separation, whereas, the random walk filter recovery loop adjust the timing pulse delay delaying the data stream with equal and fixed bit separation. Rattingourd does not suggest and teaches contrary to equal and fixed bit separation using an adjusted timing pulse delay.

Tucci used a bank of delay lines to capture the lead and lag signals, a phase locked loop to track the timing error, and a phase comparator to make adjustment. This approach is much like the early-and-late gate technique in that it estimates the amount of lead and lag, and adjusts accordingly. Therefore, while using some of the same components, this approach is quite different than the random walk filter approach.

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The cited references teach early-and-late gating using threshold detection over a data period for timing recovery. The random walk filter using clock counting over many time periods to shift the adjusted timing pulses. The invention proceeds contrary to the cited references and cited reference are thus strong evidence of non-obviousness. Allowance of the claims is requested.

Respectfully Submitted

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